Enhance Facility Energy Management at Naval Expeditionary Base Camp Lemonnier, Djibouti

12 May 2011

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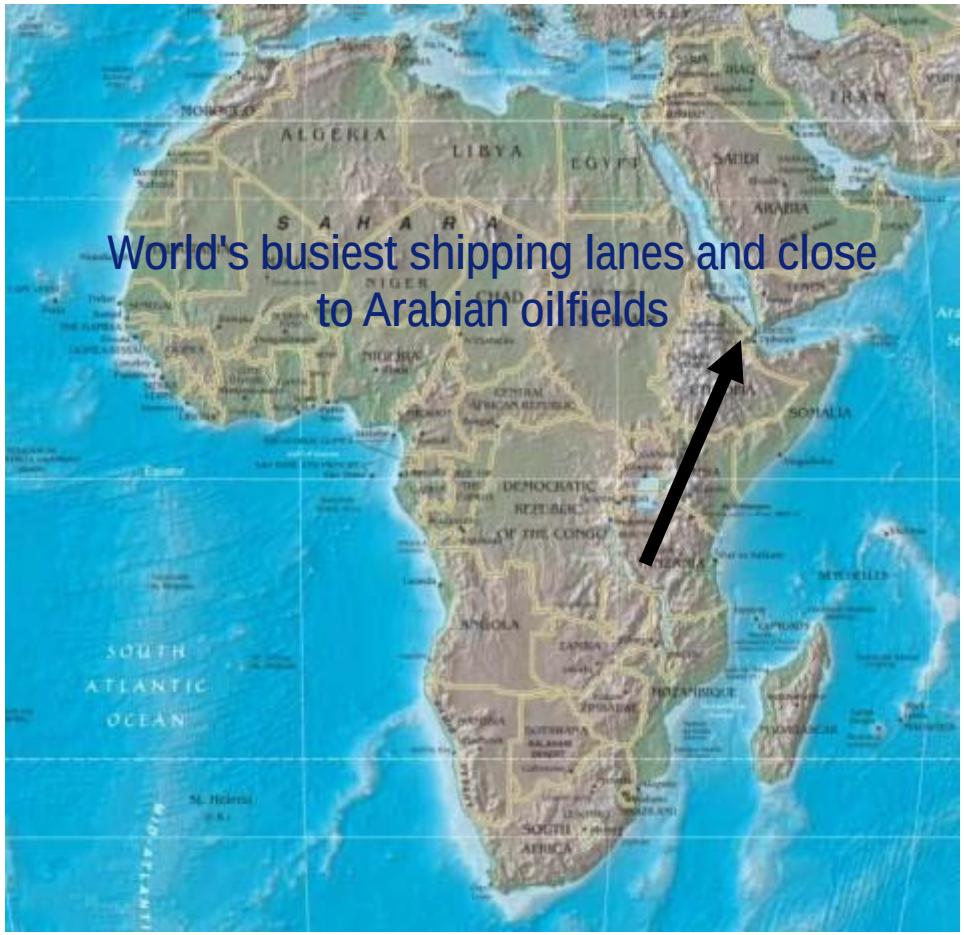

U.S. Africa Command
COMBINED JOINT TASK FORCE–HORN OF AFRICA

Mission: Conduct operations in the East Africa region to build partner nation capacity in order to promote regional security and stability, prevent conflict, and protect US and coalition interests.

Camp Lemonnier, Djibouti

- **NAVFAC Engineering Service Center - Technical Report, TR-2339-EN**


NAVFAC
Naval Facilities Engineering Command
ENGINEERING SERVICE CENTER
Port Hueneme, California 93043-

TECHNICAL REPORT
TR-2339-ENV

CAMP LEMONNIER DJIBOUTI AFRICA ENERGY AND ENVIRONMENTAL SUSTAINABILITY PROJECT FINAL REPORT FOR TASKS 1C, 2A, 2B and 2C

ATTACHMENT A

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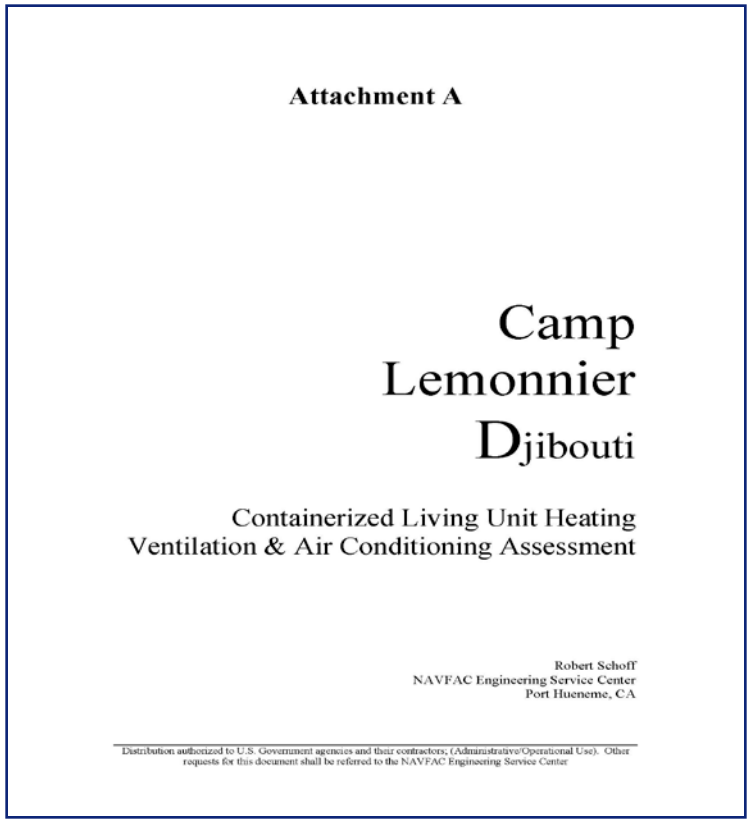
August 2010


Attachment A

Camp
Lemonnier
Djibouti

Containerized Living Unit Heating
Ventilation & Air Conditioning Assessment

Robert Schoff
NAVFAC Engineering Service Center
Port Hueneme, CA

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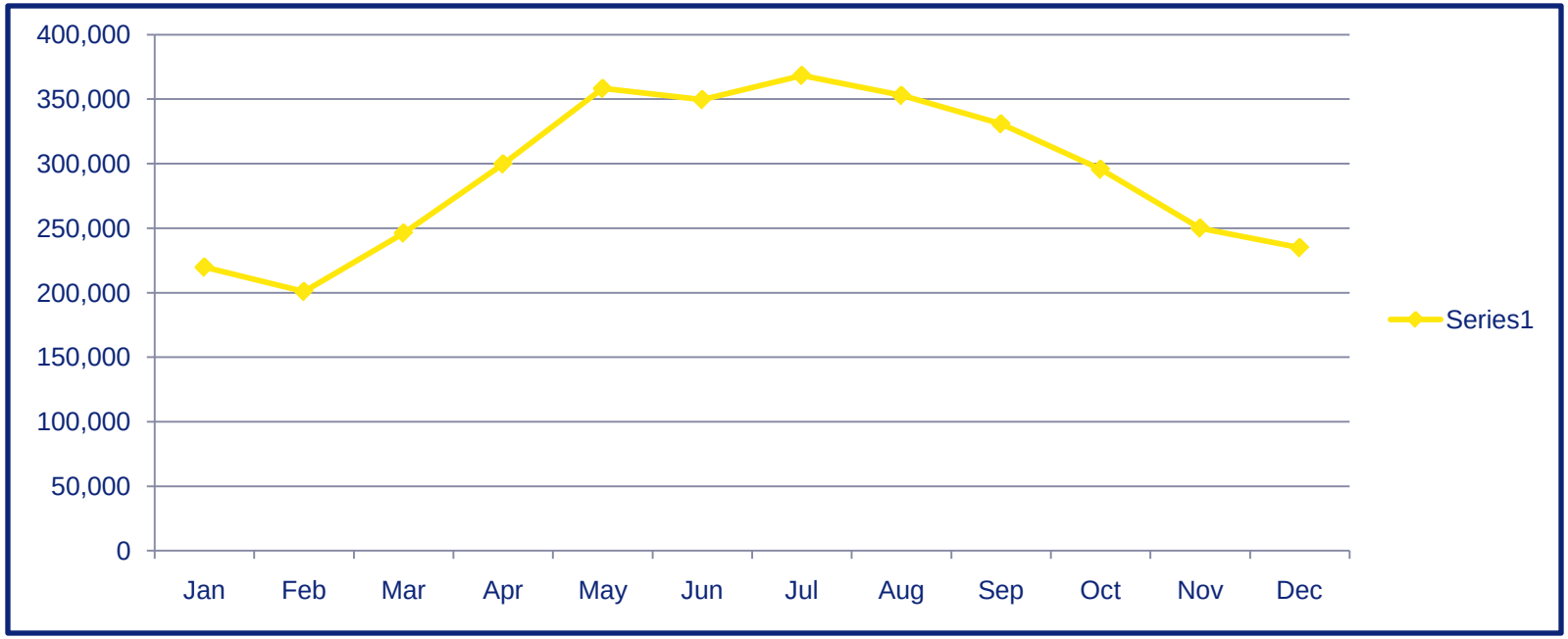
Camp Lemonnier, Djibouti

- **Harsh Environment**
  - **Average Daytime Temperature (77 to 111 °F in 2010), can reach 125 °F during the day**
  - **High Humidity (Average Dew point was 72 °F in 2010)**
  - **Average wind flow 8 mph (gusts up to 34 mph)**
- **Personnel are Quartered in Containerized Living Units (CLUs)**
- **Increasing Population**
  - **Personnel at times Outnumbers available CLUs**

Camp Lemonnier, Djibouti

- **Energy Production comes from Diesel Power Generators**
  - **Generators run 24/7 (8 x 1.3 MW Caterpillars, 6 x 0.8 MW MUSE, 130-140 smaller generators)**
  - **Approximately 11,000 gallons of diesel fuel is required to run the generators daily (2010)**
  - **Estimated monthly cost for fuel is $600K-1000K ($3 per gallon)**



Camp Lemonnier, Djibouti

Project Team:

- **NAVFAC Engineering Service Center**
  - **Abby Goss, Katelyn Rydberg, Lance Batch, Bruce Holden, Gene Griffin, Peter Ly, Bob Schoff, Christine Ahn**
- **Camp Lemonnier Public Works**
  - **LT Elizabeth Durika, CPO Miguel Fernandez**
- **NAVFAC-EURAFSWA**
  - **Bryan Long**
- **Naval Air Weapons Station China Lake**
  - **Hugh Edwards, Mathew Malone**
- **Idaho National Laboratory**
  - **Kurt Meyers**

Camp Lemonnier, Djibouti

- **Proposed Energy Conservation Methods (ECMs)**
  - **CLU Modification**
  - **Wind Profiler (Sodar)**
  - **High Efficiency Washing Machines**
  - **Incinerator Energy Recovery**
  - **Replace Street Lighting**
  - **Solar Panels with Self Cleaning Equipment**
  - **Retrofit Electric Vehicle with Solar Panels**
  - **Solar Heater for Laundry**

Camp Lemonnier, Djibouti

CLUs Current Condition

Camp Lemonnier, Djibouti

CLUs Current Condition

- **Poor Air Distribution**
- **Large Difference in Air Temperature down length of CLU**
- **Oversized ACU Cycle On and Off every 3-4 Minutes**

Camp Lemonnier, Djibouti

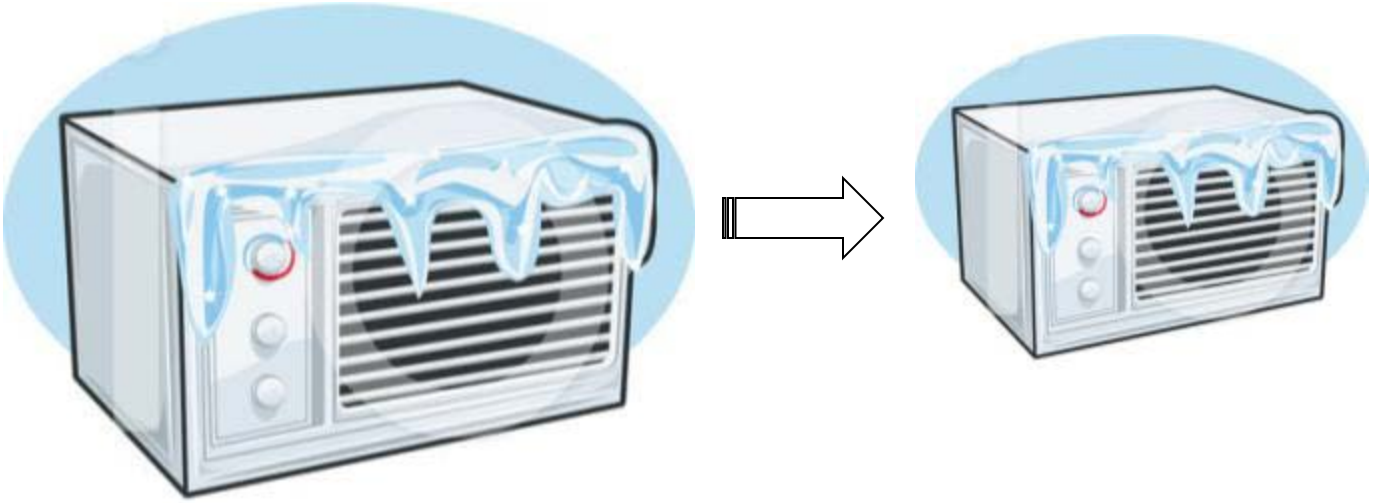
CLU Modification Constraints

- **No more than 2 hours ACU down time**
- **No displacement of occupants**
  - **Work should only be done that can be completed during the day,**
  - **While occupants are away from CLUs,**
  - **Should not disrupt sleeping hours.**
- **Modifications should not limit CLU mobility in the camp**
  - **System installed needs to be able to be broken down fairly quickly**

Camp Lemonnier, Djibouti

CLU Modification

- **Replace AC units**
  - **Reduce size of ACU from 2 Ton to ¾ Ton**
    - Reduces Load 2 Ton (24000 BT/H) to (9000 BTU/H) ACU
    - Reduces cycling (on/off) of the compressor in the ACU
  - **Higher Energy Efficiency Rating (EER)**
    - From 9.23 EER to 10.5 EER



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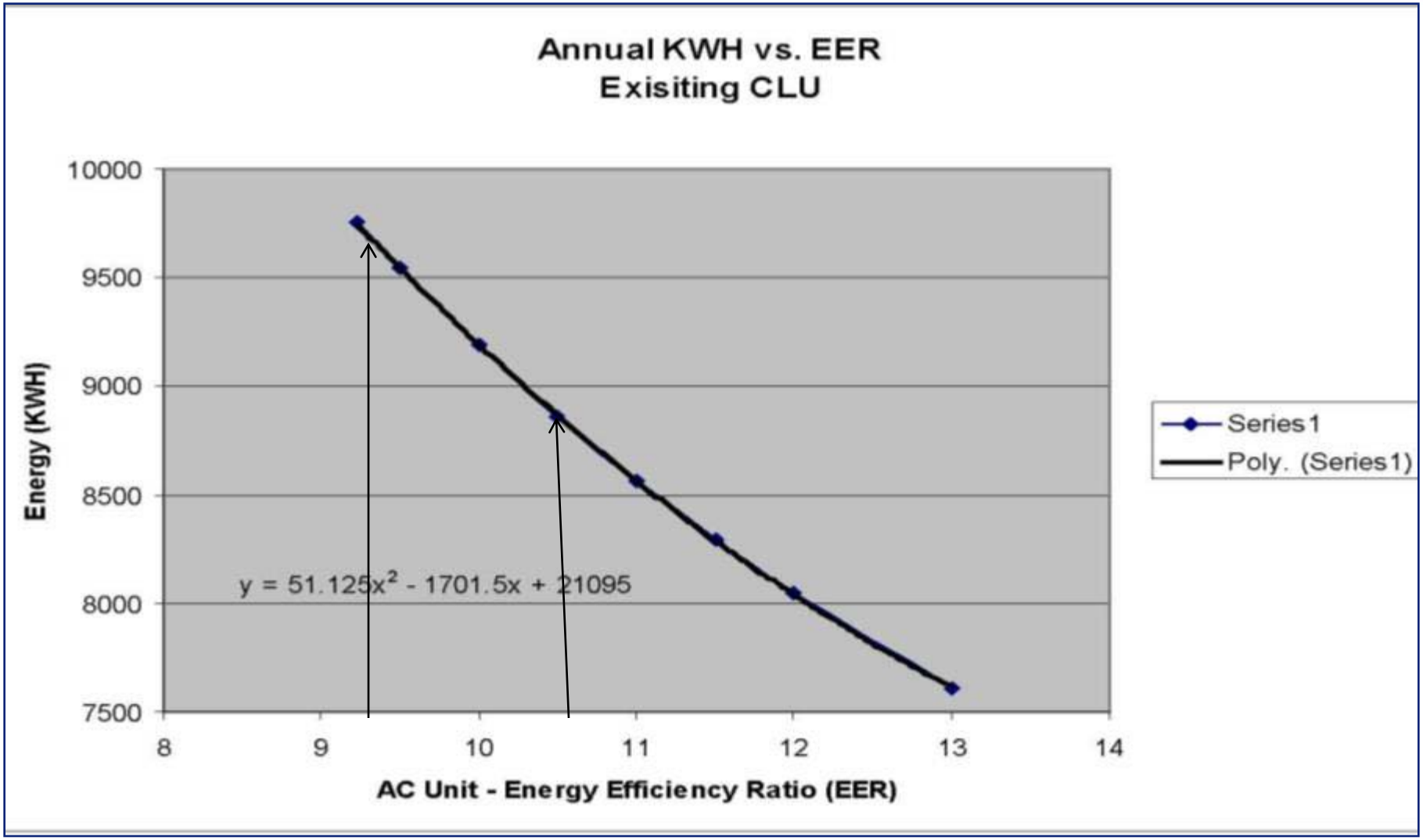

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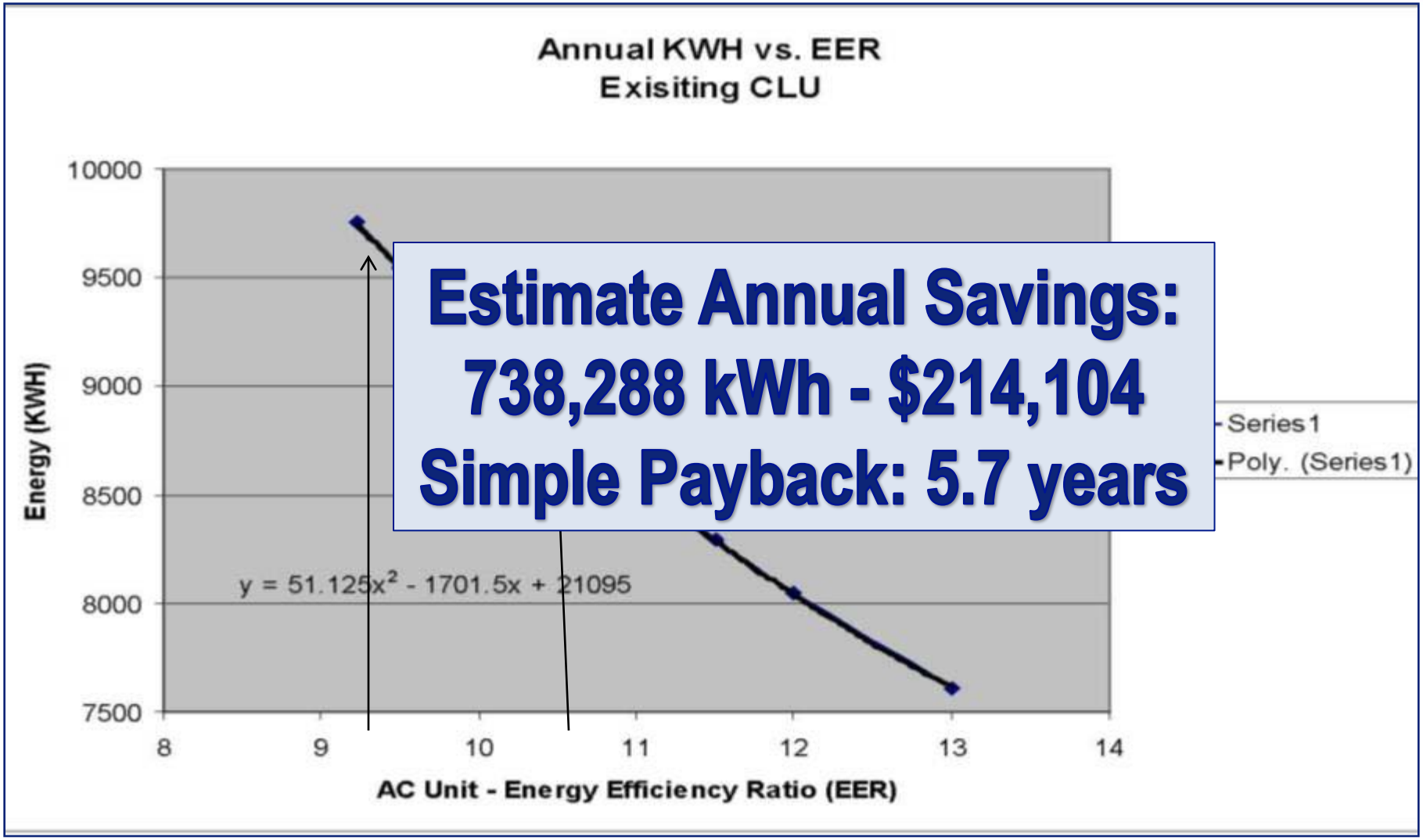


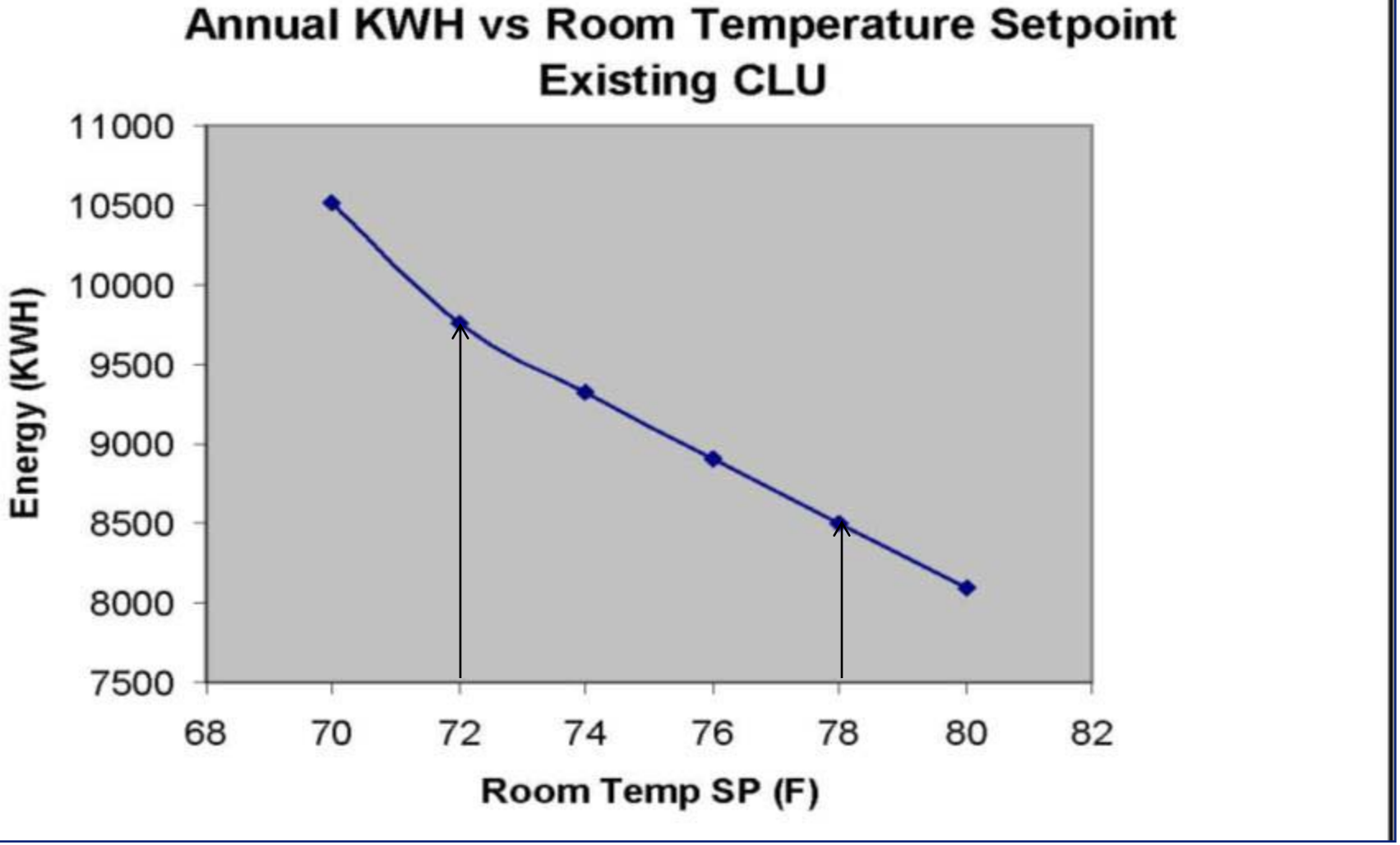
Estimate Annual Savings:
738,288 kWh - $214,104
Simple Payback: 5.7 years

Camp Lemonnier, Djibouti

CLU Modification

- **Raise Room Set point On ACU**
  - **From 72 to 78 degrees (may have to adjust for room occupant comfort)**
  - **Install Thermostat**

Camp Lemonnier, Djibouti



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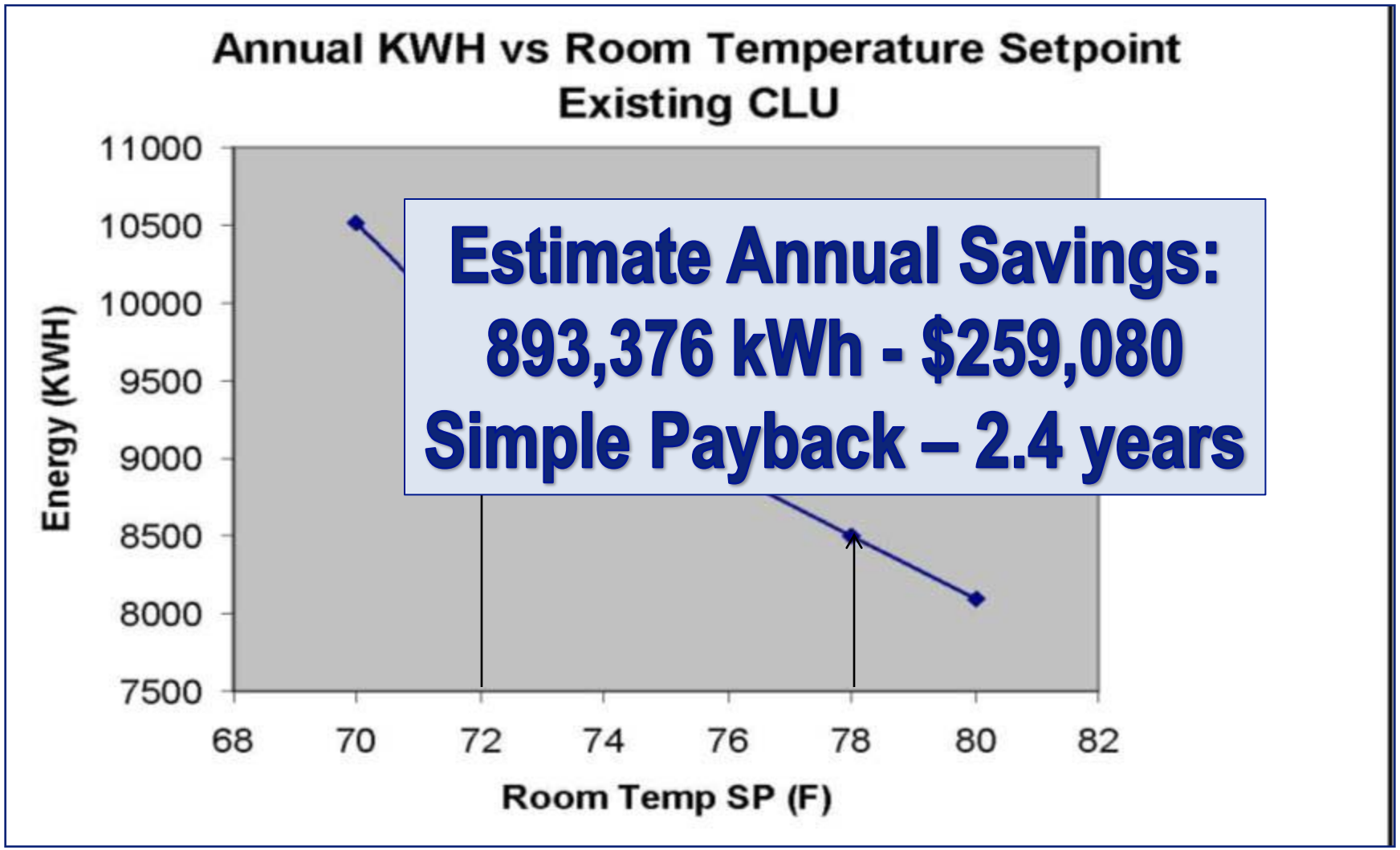
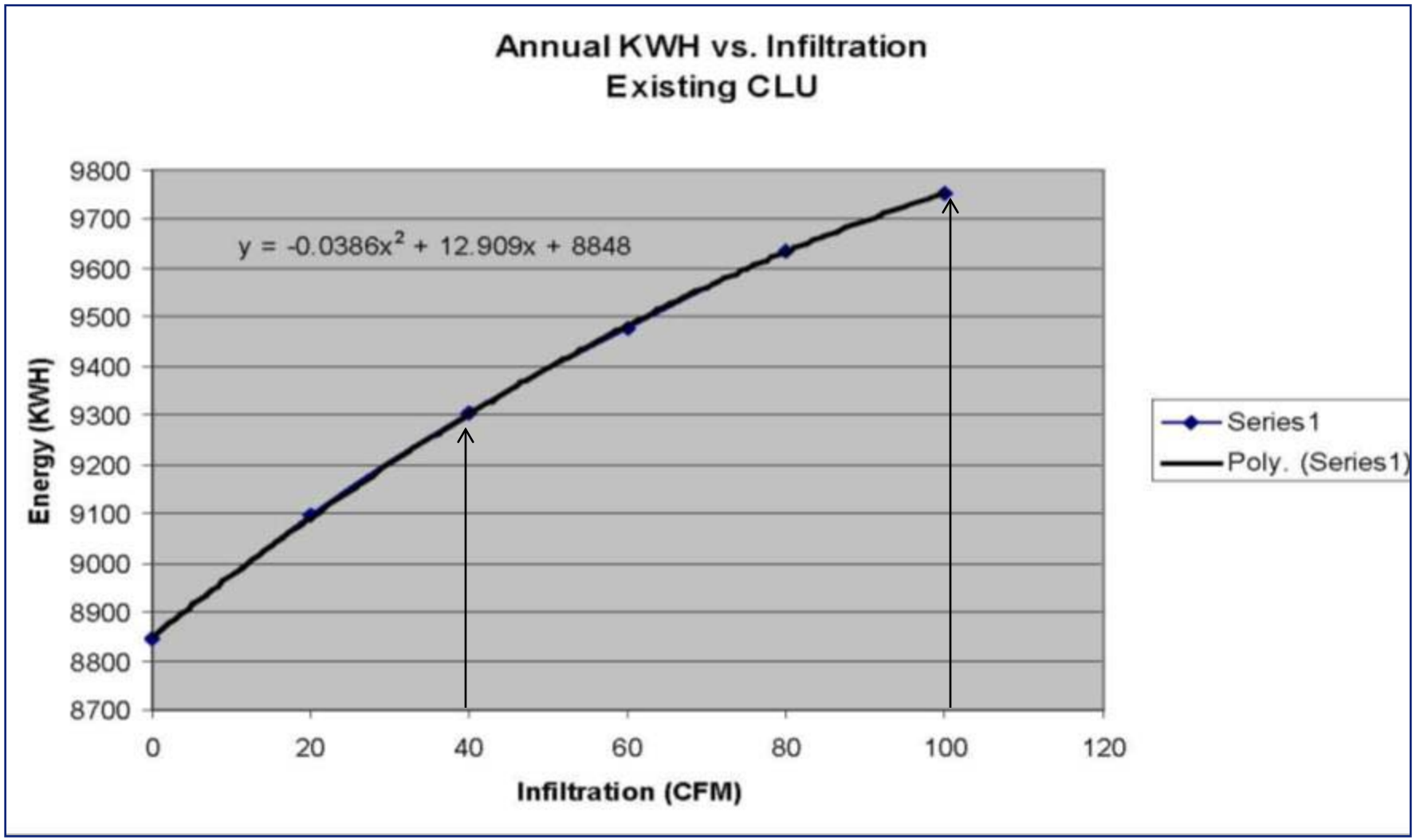


Camp Lemonnier, Djibouti

CLU Modification

- **Replace or Eliminate Exhaust Fans**
  - **Current Exhaust Fan is 50 CFM (2 per CLU)**
    - Installed to help eliminate high relative humidity, and condensation experienced within the CLUs.
  - **Replace w/20 CFM model to reduce infiltration (or eliminate exhaust fan completely)**
    - Will reduce the amount of conditioned air that is pumped out of the room during the AC unit “off” period.

Camp Lemonnier, Djibouti



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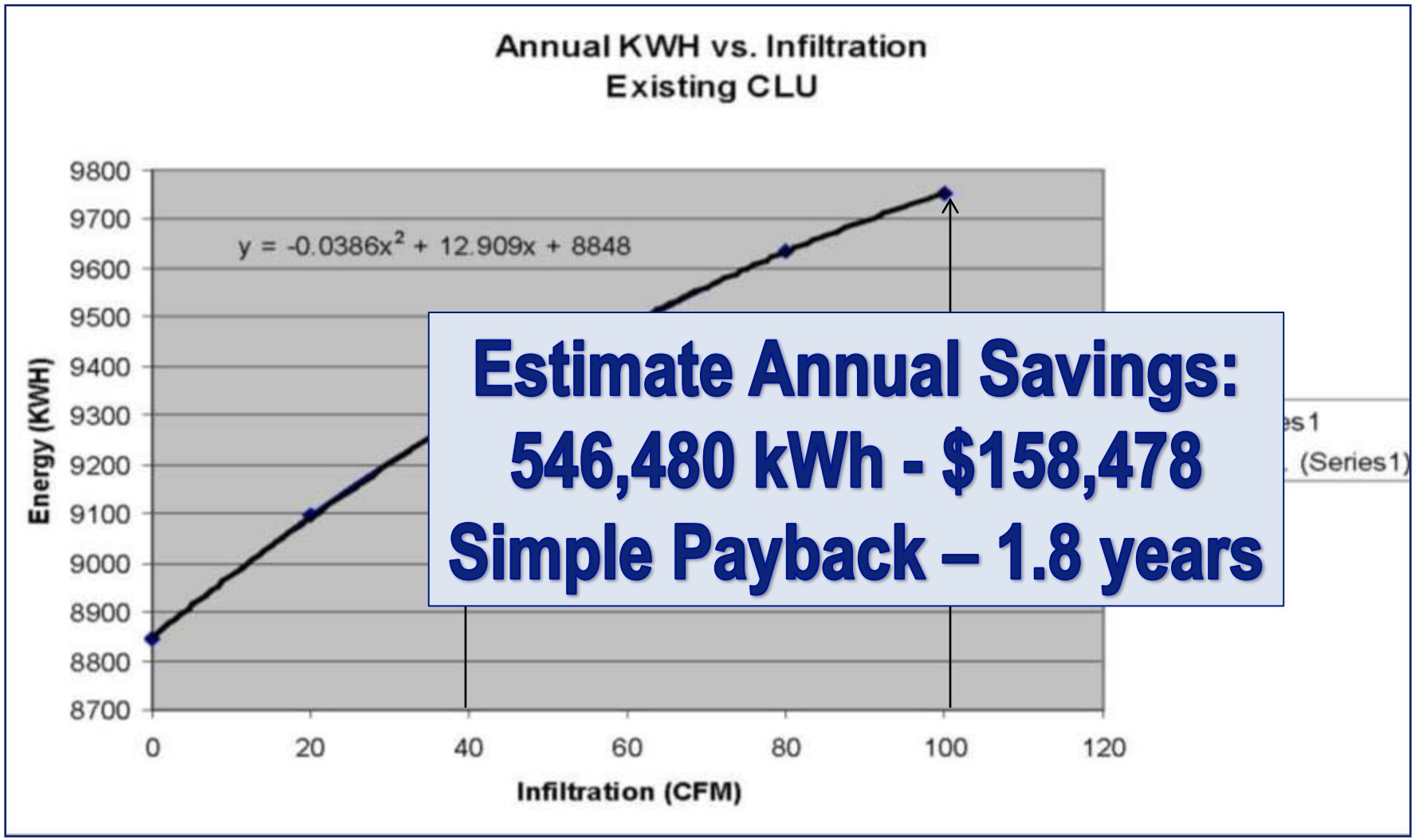


Camp Lemonnier, Djibouti

CLU Modification

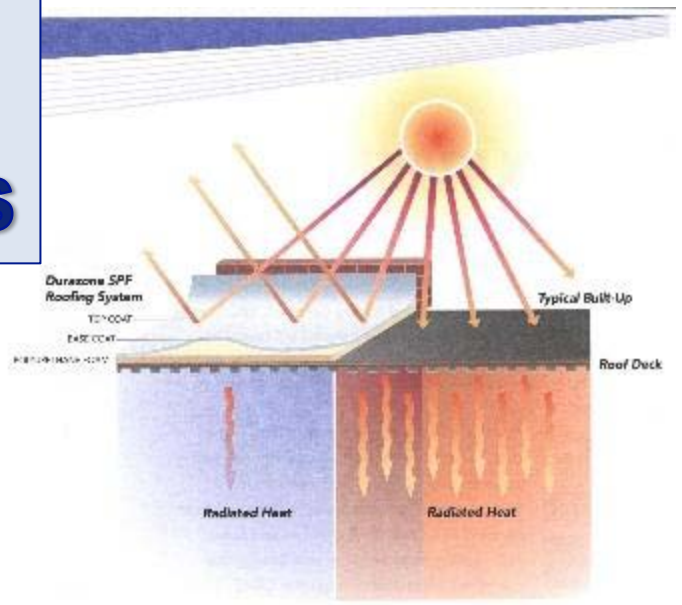
- Apply Foam Insulation to the exterior of the CLU
  - "R" factor rating of R7 per inch of material thickness.
  - Model assumes 2" of foam is applied
  - Very high insulating properties results in a substantial reduction in building load.
  - No moving parts, no new machines, etc.
  - Protects building exterior surface from elements.
  - Durable. Can be painted once dried.

Camp Lemonnier, Djibouti

CLU Modification

- **Apply Foam Insulation to the exterior of the CLUs**

Estimate Annual Savings:
921,024 kWh - $267,096
Simple Payback – 3.1 years



Camp Lemonnier, Djibouti

CLU Modification

- **Paint the exterior of the CLU (after foaming)**

Estimate Annual Savings:
409,968 kWh - $118,890
Simple Playback – 2.6 years

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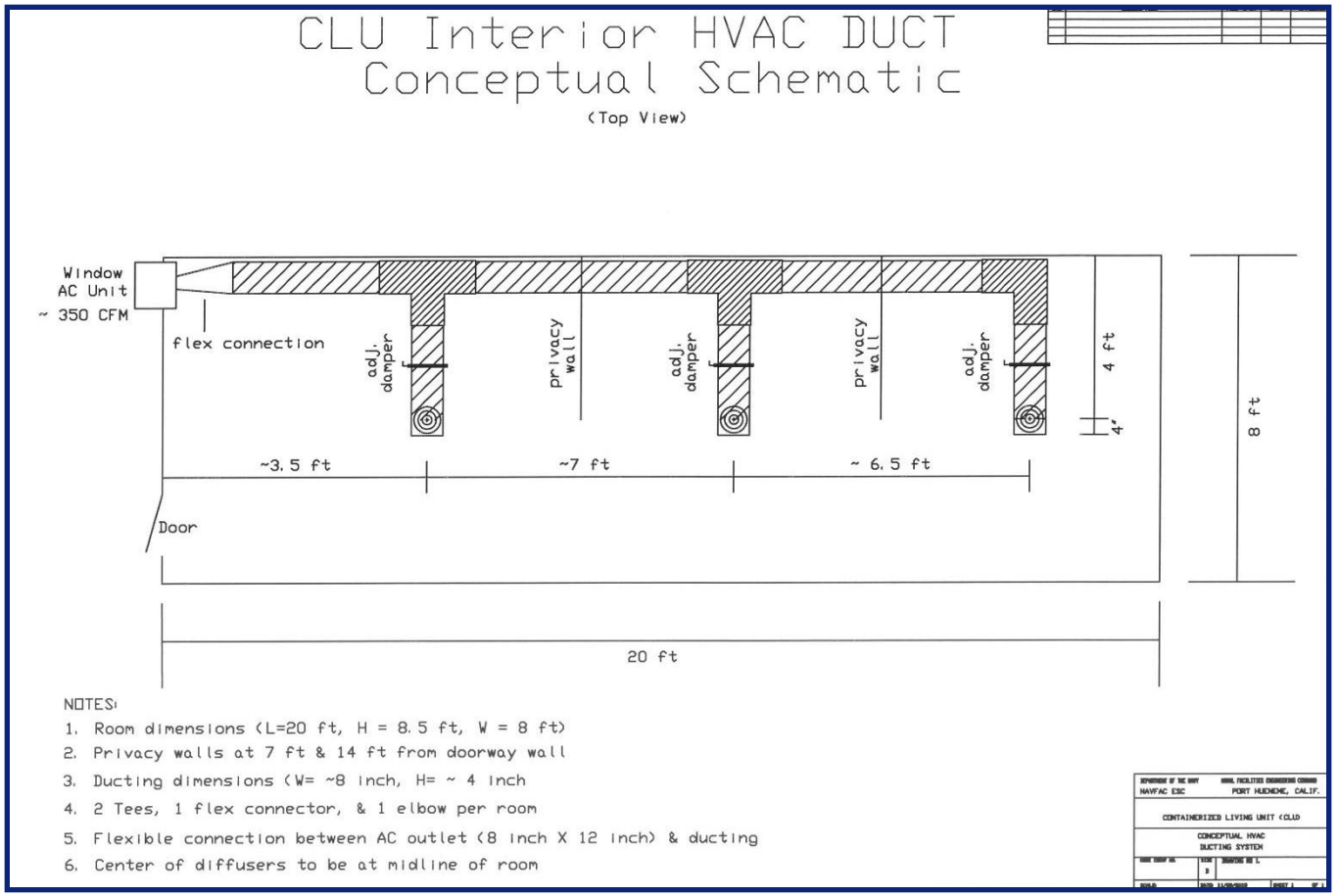
CLU Modification

- **Install Interior Ducting**



Camp Lemonnier, Djibouti

CLU Modification

- **Install Interior Ducting**
  - **The Amount of Annual Energy Saved, Fuel Funds Saved, and Simple Payback was not calculated**
  - **Better Interior Air Distribution should have the following benefits:**
    - Reduction of ACU cycling on and off
    - Uniform Interior Temperature (Currently the Occupant closet to the ACU is much colder than the Occupant further away)

Camp Lemonnier, Djibouti

High Efficiency Washing Machines

- **Reduction of Water (Energy saved from ROWPU)**
  - **Currently 34,000 gallons of water used per day at central laundry (2009)**
  - **Estimated water production cost is $908/day**
  - **High Efficiency Washers reduce**
    - Total Water by 62%
    - Hot Water by 67%
    - Energy by 28%
  - **Estimated Annual Savings for more efficient washers - $175,164 (includes ROWPU)**
- **Higher spin also leads to less water needed to be dried by electric dryer**

Camp Lemonnier, Djibouti

High Efficiency Washing Machines

- **Reduction of Water (Energy saved from ROWPU)**

Estimate Annual Savings: $175,164

Simple Playback – 0.25 years

  - Total Water by 62%
  - Hot Water by 67%
  - Energy by 28%
  - **– Estimated Annual Savings for more efficient washers - $175,164 (includes ROWPU)**
- **Higher spin also leads to less water needed to be dried by electric dryer**

Camp Lemonnier, Djibouti

Incinerator Energy Recovery

- **Waste Characterization Study needed to determine amount of energy that can be captured**
- **Estimated Power Generation of about 477 kW/hr**
- **May be able to Produce 5% of the total base energy need**

Camp Lemonnier, Djibouti

Incinerator Energy Recovery

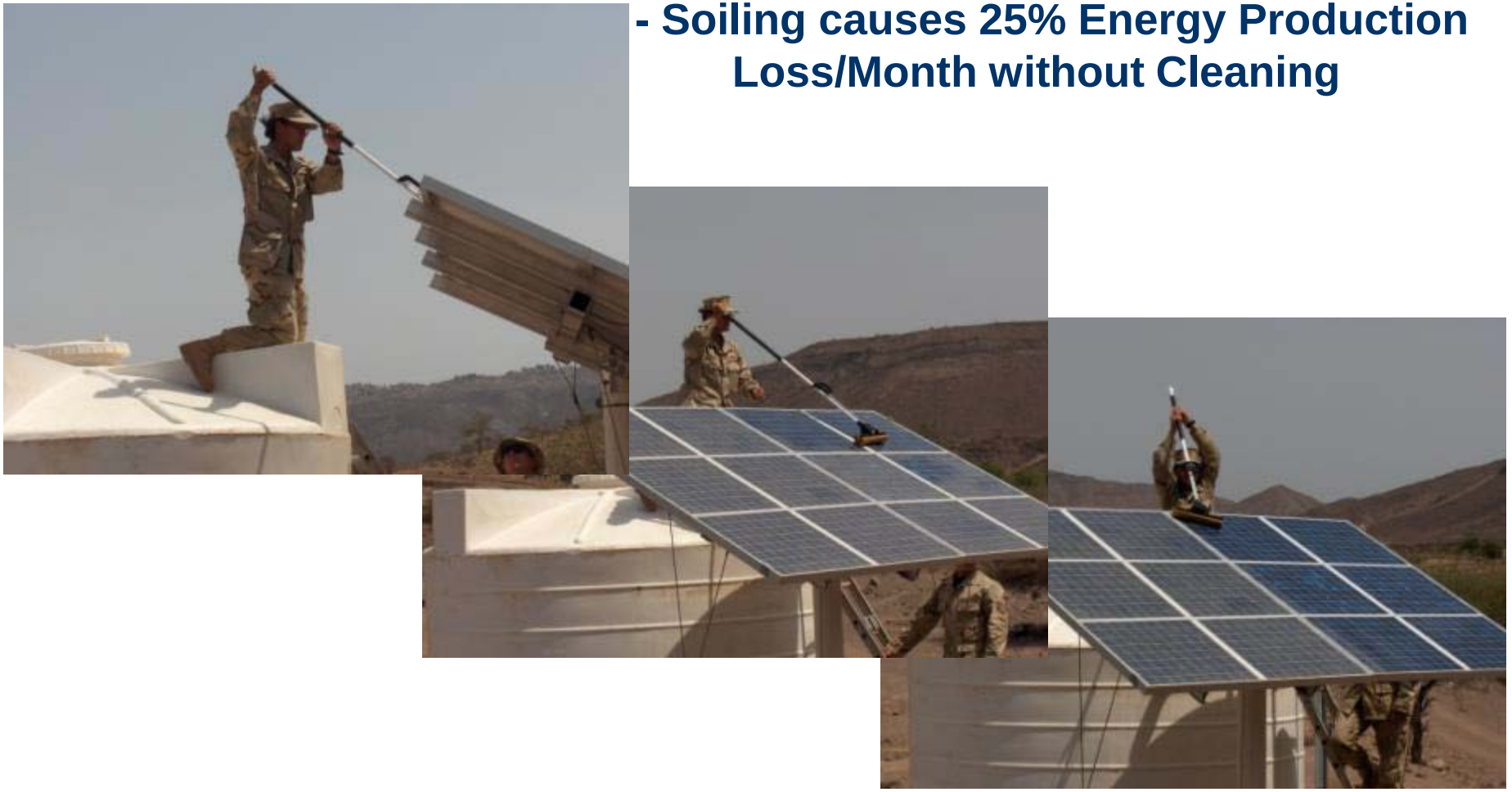
- **Waste Characterization Study needed to determine amount of energy that can be captured**
- **Estimated Power Generation of about 477 kW/hr**
- **May be able to Produce 5% of the total base energy need**

Estimate Annual Savings:
$526,089
Simple Payback – 2.4 years

Camp Lemonnier, Djibouti

Solar Panels with Self Cleaning Equipment

- Soiling causes 25% Energy Production Loss/Month without Cleaning



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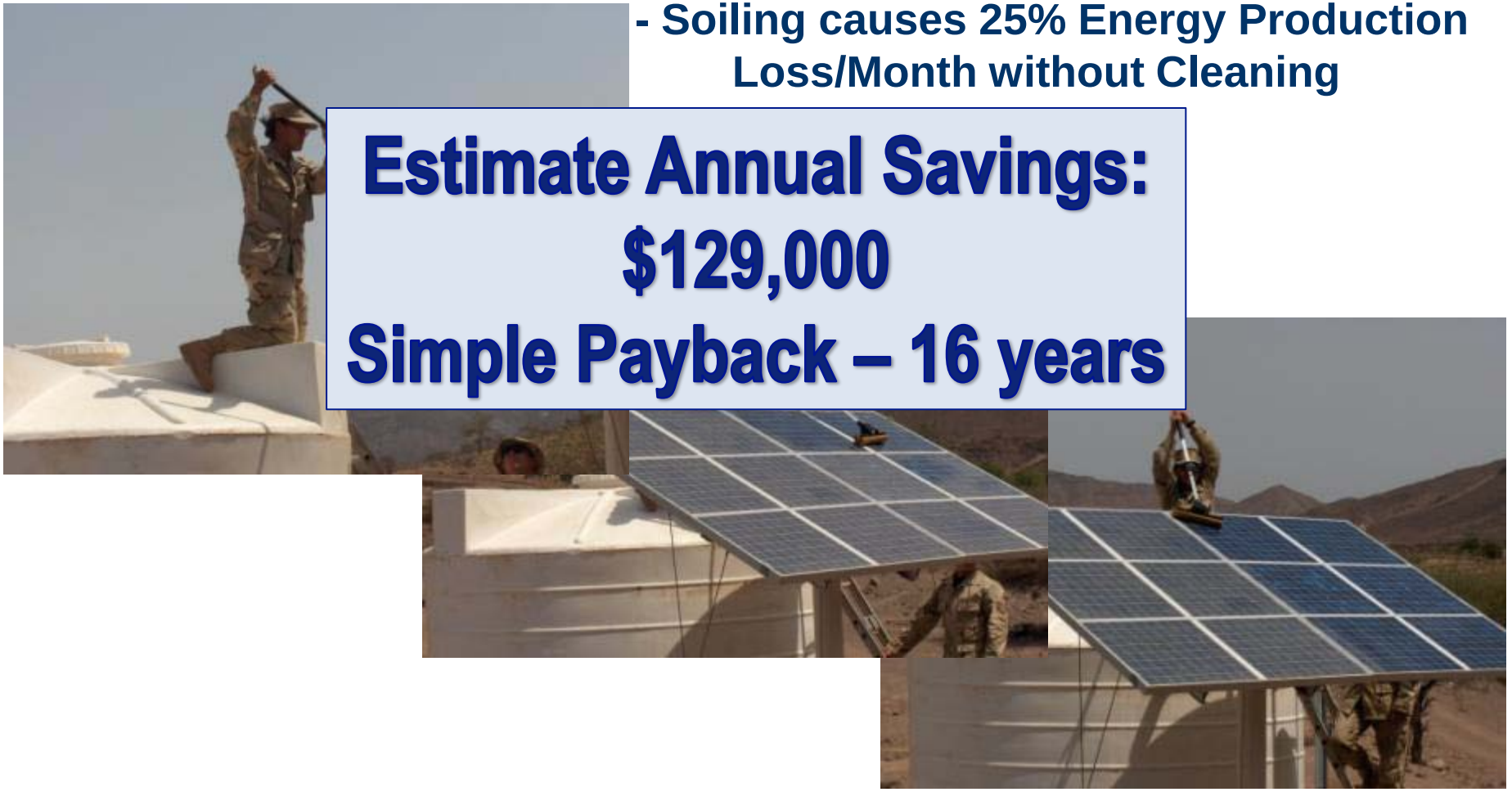
Solar Panels with Self Cleaning Equipment

- Soiling causes 25% Energy Production Loss/Month without Cleaning

Estimate Annual Savings:
$129,000
Simple Payback – 16 years



Camp Lemonnier, Djibouti

Solar Heater for Laundry

- **Reduction or elimination of energy used by electric water heater in main laundry and mess hall**
  - **May also have an effect on the ACU**

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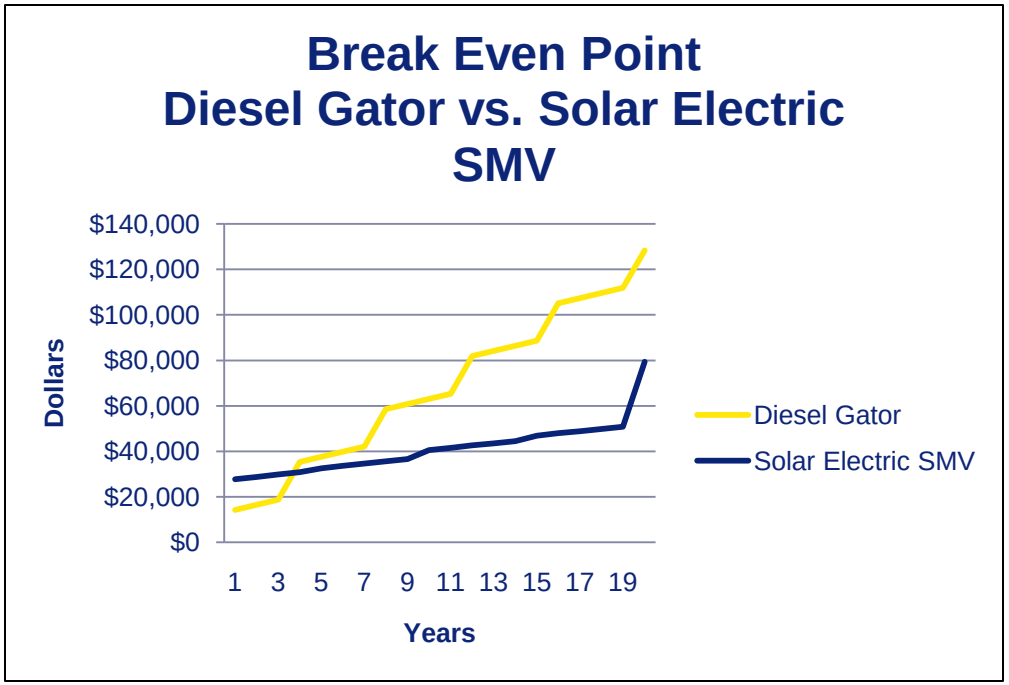
Retrofit Electric Vehicle with Solar Panels



Camp Lemonnier, Djibouti

- **Replace Street Lighting**

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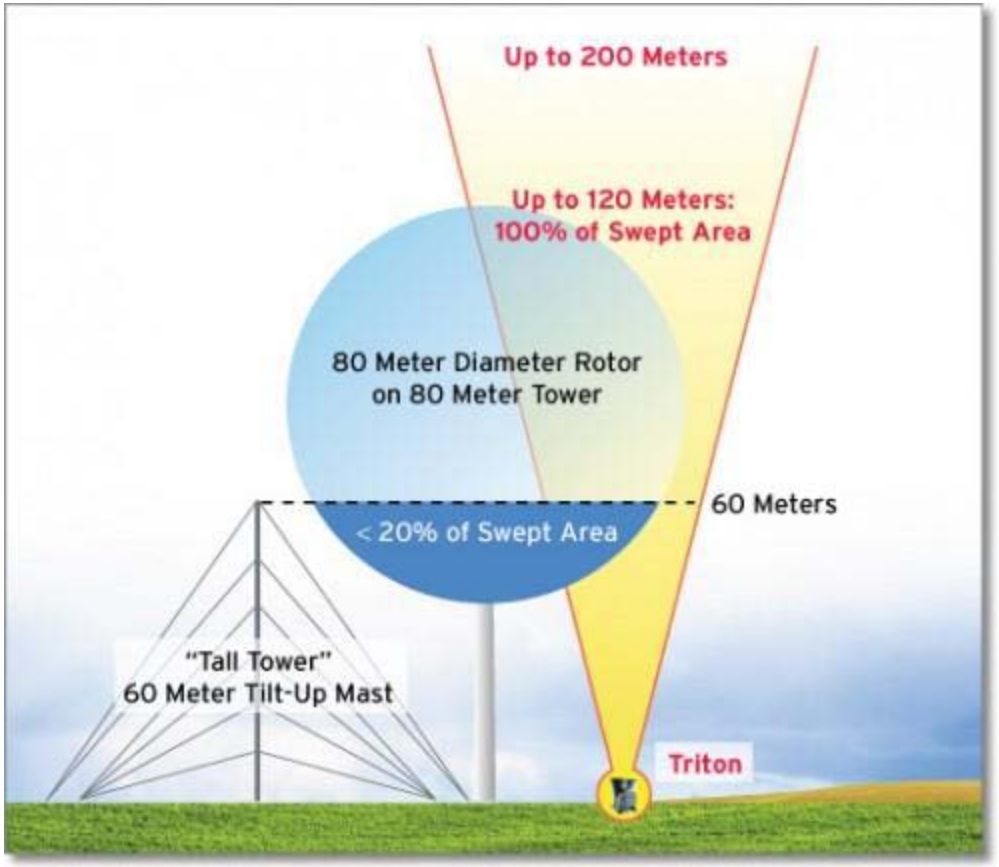
Wind Profiler (Sodar)



Camp Lemonnier, Djibouti

Total Annual Estimated Energy Savings

- **CLU Modifications – $1,017,648**
- **Incinerator Energy Recovery - $526,089**
- **High Efficiency Washers - $164,205**
- **Solar Panel – $129,000**

Camp Lemonnier, Djibouti

QUESTIONS?